World Pulp & Paper

THE INTERNATIONAL REVIEW FOR THE PULP AND PAPER INDUSTRY

2019

Enzymatic technologies provide a new level of stickies control

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ABSTRACT

Stickies contribute to a significant reduction in efficiency in the practice o papermaking using recycled fibre. The presence of adhesives, binders, tapes and other stickies-creating materials in the incoming pulp leads to machine downtime, a reduction in converting efficiency, final product quality issues and increased waste.

Enzymatic technologies have proven successful in providing stickies control in mills over the past decade; however, on their own they were not able to solve the problem completely for certain types of contaminants. Greater control of stickies at paper mills is now being achieved by combining new generation enzymatic formulations with specific additives to stabilise enzymatic resistant stickies. This approach keeps the stickies small, dispersed, and non-tacky to eliminate agglomeration downstream and keep them fixed into the outgoing sheet. The latest generation of enzymatic technologies has proven to lead to a superior level of stickies control than previous generations.

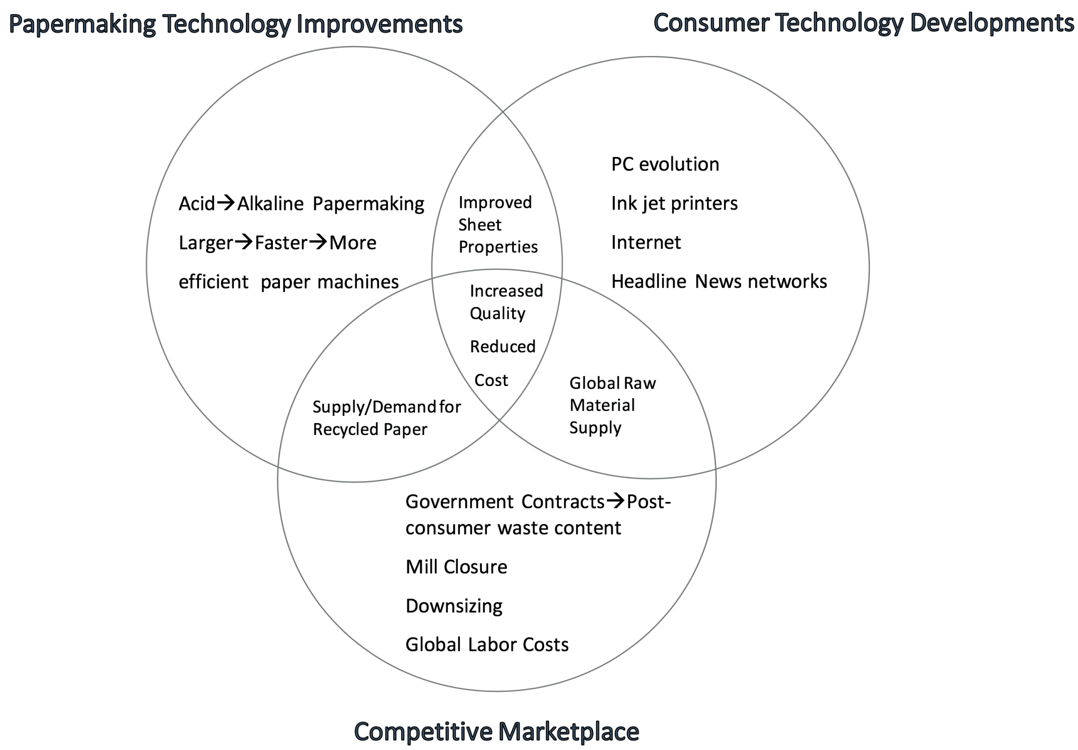

Diagram 1. *Emerging technologies and market place drivers that continue to reshape the recycled fibre market.*

BACKGROUND

Over the last 40 years the paper industry has experienced several market forces that have influenced the direction of recycled fibre utilisation. Many surveys of industry experts have been conducted which indicated that stickies-related sheet quality and machine runnability problems have increased mainly due to marketplace demands for higher sheet quality performance. In order to be competitive in today's market, papermakers must continue to respond to these ever-increasing sheet quality expectations. The papermakers rely on procedural, mechanical, and chemical methods to control stickies-related problems within their operation. The scope of this article is limited to chemical treatments. Additionally, environmental improvement efforts have limited the use of prevailing chemical technologies for stickies treatment. These main drivers that have influenced recycled fibre utilisation can be categorised as technology advancements, the competitive marketplace, and environmental requirements.

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Technology Advancements: Papermaking technology improvements as well as the consumer technology evolution have taken sheet quality expectations to higher levels. The main dilemma is centered on the notion that the paper industry's quest to meet the market demands for higher sheet quality standards is one of the main contributing factors to the problems associated with stickies. The cycle starts with a consumer need to enhance the look and feel of a paper product. A marketing company may request that their paper have improved brightness, softness, strength, or printability in order to create a more distinctive and vibrant advertisement. In order to meet this demand, the competitive marketplace drives chemical innovation. It is this very innovation that leads to the creation of improved ink binders with longer water penetration hold out. As these improved ink binders become a part of the recycled fibre market, the same innovation that led to their development results in a sheet with more tenacious stickies deposits. Several paper industry technology advancements are highlighted in Diagram 1.

Competitive Marketplace: The paper industry has experienced company consolidations, paper demand reductions, and global capacity realignments that have affected the distribution and usage of recycled fibre. Diagram1 depicts the emerging technologies and market place drivers that continue to reshape the recycled fibre market. Many of these factors represent challenges for papermakers. Global recycled fibre demands have influenced the price and quality of recycled fibre. Papermakers no longer demand clean, consistent recycled fibre from their suppliers. Instead, papermakers accept lower quality, contaminated recycled fibre because it is affordable and available. At the same time, chemical innovation has increased the tackiness of stickies, and global recycled fibre demand has increased the potential for increased contamination in recycled furnish.

Environmental Requirements: Throughout the 1970s, 1980s and 1990s, the U.S. Environmental Protection Agency enforcement efforts have caused papermakers to scrutinise the chemical additives used in the papermaking process. Some of the reliable cleaning agents used in the 1970s and 1980s have been phased out due to environmental restrictions. Even some of the less aggressive detergents used in the 1990s have been banned due to clean water and clean air regulations. Currently, several paper companies have implemented a lower risk approach to chemical additives by eliminating the use of products that contain even the slightest level of hazardous pollutants. As much as the improved quality demands and the competitive global marketplace have adjusted the stickies control arena, the environmental regulations have changed the pool of potential chemical actives available for use as stickies control products. Figure 1 highlights some of these areas of concern.

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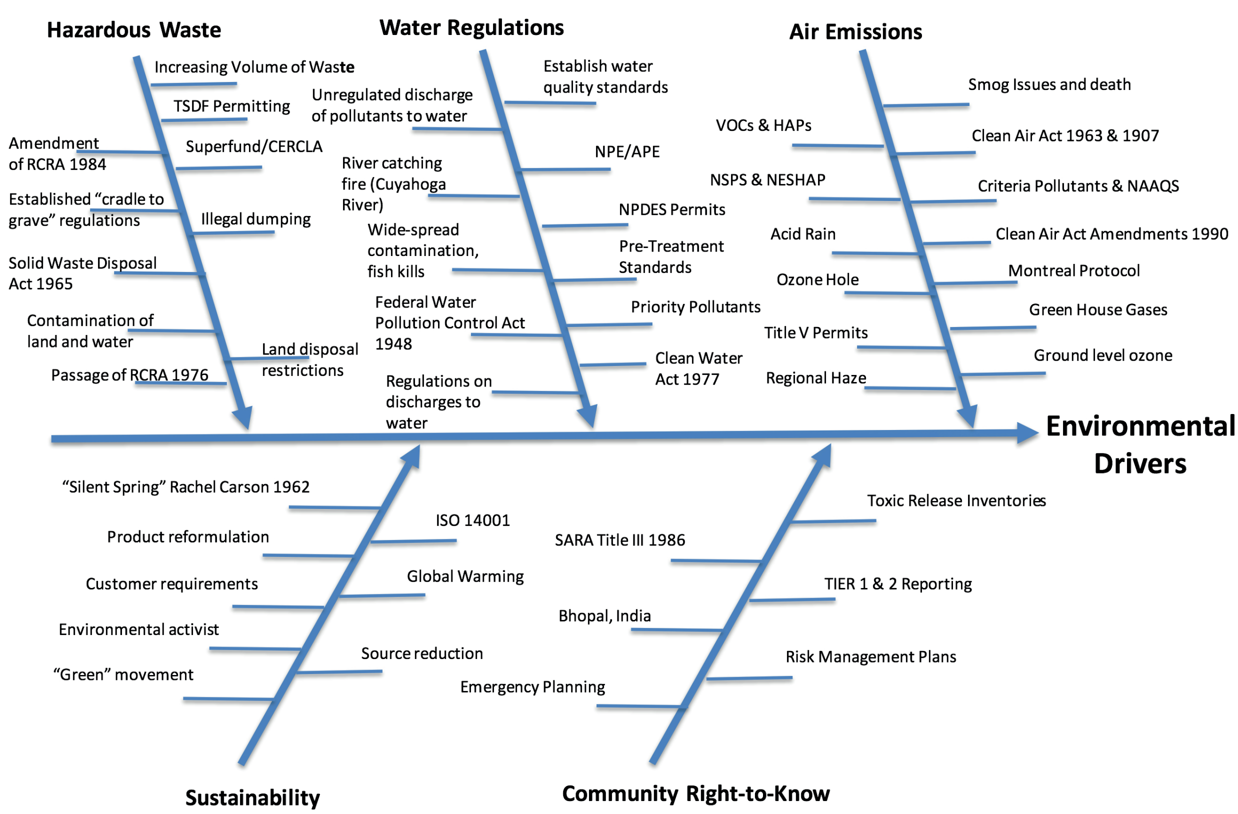

Figure 1.
Environmental drivers.

DISCUSSION

These market forces have shifted the perspective of consumers into a new competitive marketplace full of increased sheet quality possibilities. In order to be competitive in today's market, papermakers must continue to respond to these ever-increasing sheet quality expectations. The papermakers rely on several methods to control stickies-related problems within their operation. The scope of this paper is limited to chemical treatments. A survey of papermaking experts confirmed that the level of sheet quality expectations appears to be increasing at a much faster pace than the chemical stickies control technologies.

The traditional chemical control strategies have improved over the years. In some cases, the demand for increased sheet quality has outrun the capacity of chemical treatments to control stickies-related problems. Once a mechanical contaminant removal process has been optimized, papermakers rely on chemical treatments to control the remaining stickies-related issues. It seems that chemical stickies control technologies were simply falling further behind the rapid increase in stickies-related machine runnability and sheet quality complications caused by these increased sheet quality demands. Papermakers were frustrated with chemical treatments that seemed to transfer the stickies from one area of the machine to another surface or end up in the sheet as a large agglomerated stickie causing converting issues.

TABLE 1

Classification	Chemical Name	Alias Name	Sources
Acetate	Ethylene-vinyl acetate	PVAc, EVA	OCC, MOW, OMG
Acrylate	Vinyl Acrylates	Ink	MOW, OMG
Rubber	Styrene Butadiene Rubber	SBR	MOW
	Polyisoprene	Natural Rubber	MOW
	Polybutadiene	Synthetic Rubber	MOW
	Polychloropene	Neoprene	MOW
Plastic	Polyvinyl chloride	PVC	OCC
	Polypropylene		OCC
	Polyethylene	PE	OCC

Table 1. *Major classification of stickies shows the complexity surrounding the chemical nature of stickies.*

One reason for this gap between sheet quality and chemical technology performance is that most of the chemical treatment strategies do not address the root cause of stickies-related problems. To effectively manage stickies, they must be purged from the process. Table 1 summarises the major classifications of stickies to provide a more comprehensive appreciation for the complexity surrounding the chemical nature of stickies.

It is worth noting that the chemical nature of stickies continues to evolve as glue manufacturers continue to develop new technologies.

More than 15 years ago Buckman introduced the pulp and paper industry to enzymatic stickies control with their Optimyze® technologies. These products have proven successful in controlling stickies in many mills but could not always eliminate the stickies issues completely. One of the main reasons for this result is that this line of enzyme-based stickies control products contained one enzyme that broke bonds mainly in the Poly Vinyl Acetate (PVA) type stickies. While the PVA stickies make up a large proportion of problematic stickies, there are always other stickie types that contribute to the issue. In addition, in most cases, stickie deposits contain wood pitch and other additives.

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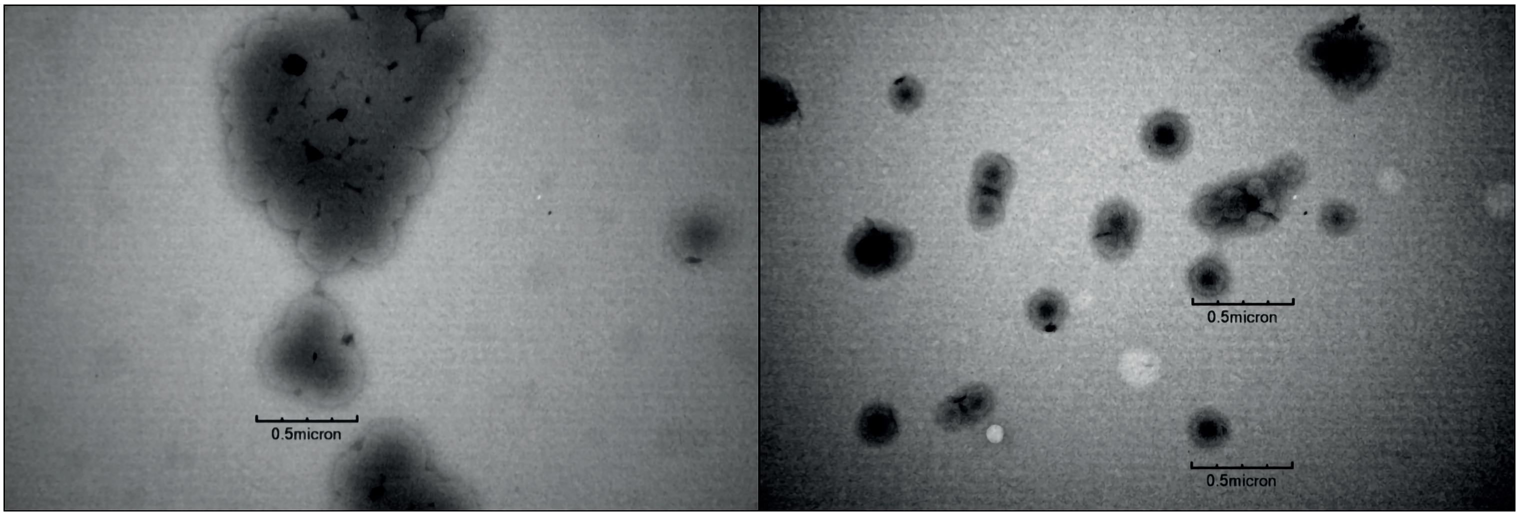

Figure 2. *Micrograph showing the effect of Optimyze® on the stickie's size.*

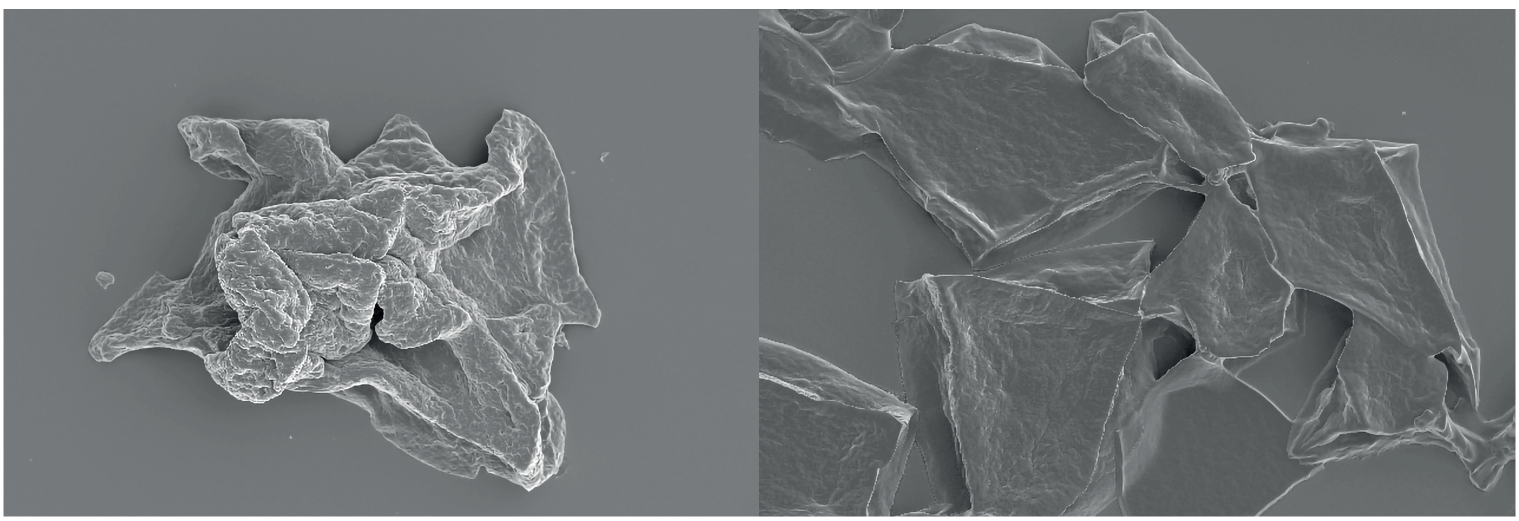

Figure 3. *SEM image showing the effect of Optimyze® on the stickie's surface.*

Enzymes are naturally occurring proteins that are used by living organisms to enhance the efficiency of specific chemical reactions. Enzymes are not consumed in a single reaction. In fact, enzymes can participate in millions of reactions per minute. However, system conditions such as pH, temperature, or interfering chemical residuals will break down enzymes over time. The enzymes in this product act together as a catalyst to facilitate the hydrolysis of the ester linkage of stickie materials containing acetate and acrylate components. This hydrolysis reaction alters the chemical structure of the stickie resulting in a less stable, less tacky material. The chemically altered stickie complex breaks apart into smaller particles. Figure 2 shows the effect of the enzymatic treatment on stickies size. Figure 3 shows the effect of the enzymatic treatment on surface changes and reduction of tackiness.

To help close the gap created by worse quality furnish and changes in stickies chemical composition between increased sheet quality demands and chemical technology performance, Buckman has developed a new generation of products. These products are more robust and addresses a broader range of stickie contaminants: the Optimyze® Plus technologies. These new products all contain combinations of different stickies control chemistries. It can be a combination of enzymes or enzymes with other types of stickies control chemistries. The result is products with a broader range of activity in controlling problematic stickies. These products are patented technologies.

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Current applications

CASE HISTORY 1

A South American Kraft/Recycled linerboard mill suffered from severe issues with stickies, causing holes, breaks and lots of costly downtime to regularly wash up. A specific enzymatic formulation was used to solve this problem for immense benefits, including:

- Cleaner system, reduction in hemocytometer (pitch/stickies) test measurements
- Increased production, less stoppage due to breaks and forced downtime for washups
- Significant ROI per year

The product was applied to treat the stock that goes to the three paper machines PM#A, PM#B and PM#C, as shown in Figure 4.

The basic paper mill conditions are listed in Table 2.

For all machines, the costs were reduced with Optimyze® Plus 727 over the diatomaceous earth program. The monitoring technique practiced by the mill was to monitor hemocytometer counts exiting Stock Tower 4. The hemocytometer counts were reduced by 61.3%, indicating a statistically significant reduction in stickies.

This translated directly into increased production on two of the three machines. The new stickies control program increased production on PM#A and PM#B. The new program increased the production at PM#A by 11% (1063 ton/month) and at PM#B by 9.8% (346 ton/month).These were mainly due to less breaks and no forced washups due to stickies. Aside from great savings, the mill personnel were very happy to not have to clean and thread the machine so often.

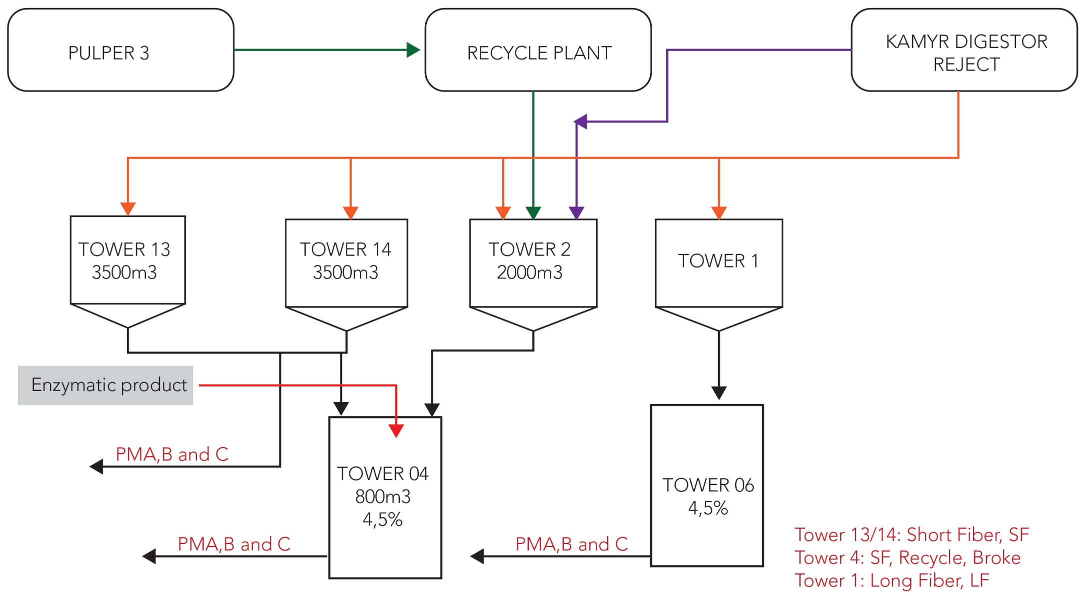

Figure 4. *Mill diagram showing addition point for Optimyze.*

Paper machine:	
Grade	Kraft liner (recycled content)
Furnish	60% mix of SF + recycle (variation of 20-80% from each) and 40% mix 75% SF + 25% LF
Former	Fourdrinier with top former
Production rate	1372 tpd
Application point pH	9.2
Headbox pH	6.3
Headbox temperature	50°C
Additives:	
Diatomaceous earth	2.0 kg/ton, to stock tower ← **Replaced**
Coagulant cationic	1.7 kg/ton, blend chest outlet
Cationic starch	4.5 kg/ton, blend chest inlet
PAC	2.0 kg/ton, fan pump suction
Rosin emulsified size	2.0 kg/ton, before screen
Silica	4.0 kg/ton after screen
Alum	9.0 kg/ton, whitewater
Deposit control (Busperse® 2454)	0.6 kg/ton, water system
Optimyze® Plus 727	0.4 kg/ton, to stock tower (tower 4 inlet) ← **Added**

Table 2. *Paper machine information and additives.*

CASE HISTORY 2

A North American Fourdrinier machine was producing 650-720 tpd recycled medium from 100% OCC. This machine had difficulties in reaching budgeted production for the last year due to stickies related runnability issues. Stickies contamination is primarily poly vinyl acetate that causes dryer can and felt deposits. When deposits build, moisture variations in drying occur and even break free causing debris breaks. The cost of the problem annualized is more than $2.5 million of lost production and increased steam demand.

Problem Description:

- Sampled deposits from press rolls, dryer fabric, and dryer rolls tested positive for PVA stickies.
- As agglomerated stickies adhere to wire, wet felts and dryer fabrics the CD 2 sigma moisture profile starts to move upward.
- Machine tenders then spend a significant amount of time chasing the profile with slice and steam box adjustments.
- In wet spots, the slice is restricted to feed less fibre in hopes of allowing the sheet to dry evenly.
- As Concora test results drop in those areas, basis weight is then added to improve the overall sheet strength.
- Once the issue becomes unmanageable, downtime is required to batch wash the dryer felts.
- When large stickies deposits break free in the dryer sections they cause holes/breaks referred by the mill as "debris breaks".
- In addition to the lost time from washups and breaks, the mill has to reject a significant amount of production for high CD 2 sigma moisture profiles, and decrease speed to make quality tests.

In an attempt to reduce debris related breaks, the mill added a significant amount of a detackifier to the machine chests. This attempt was unsuccessful as the #1 machine had to continue to perform unscheduled boilouts.

Stickies contamination is primarily poly vinyl acetate that causes dryer can and felt deposits. When deposits build, moisture variations in drying occur and even break free causing debris breaks.

An extensive site survey (pH, temp, oxidants, consistency, contact time) needed to be conducted to ensure the environment is conducive for the enzyme package.

A different enzymatic product than the one used in the previous case was initially added to the short fibre surge chest pump feeding the HiD at 1#/ton. Stickies testing was performed on stock samples and repulped retains using the Buckman macrostickies dye method. Machine key performance indicators were measured in CD 2 sigma moisture profile, Uhle vacuum levels, steam demand, breaks, downtime for washing, rejects by reason (team leader report), and stickies deposits at the winder. After a few upsets with the HiD tank inventory running low, we made an application point change to the top of the short fibre surge chest which gave us an extra 30 minutes of contact time.

Although we performed daily composite macrostickies testing, the true key performance indicator was the CD 2 Sigma moisture variation on the machine. This moisture profile directly correlated to stickies buildup and fabric cleaning. The Xbar –R Chart (left) shows moisture variation in hourly subgroups of 48 by pre-trial, trial, and post-trial.

The next building block in establishing efficacy is the measure of steam demand. Dryer steam demand will decrease with consistent and even drying. Less buildup on the dryer cans and fabrics allow the mill to use less steam. Note that in times of breaks, reduced production, or runnability bottlenecks, steam demand will also

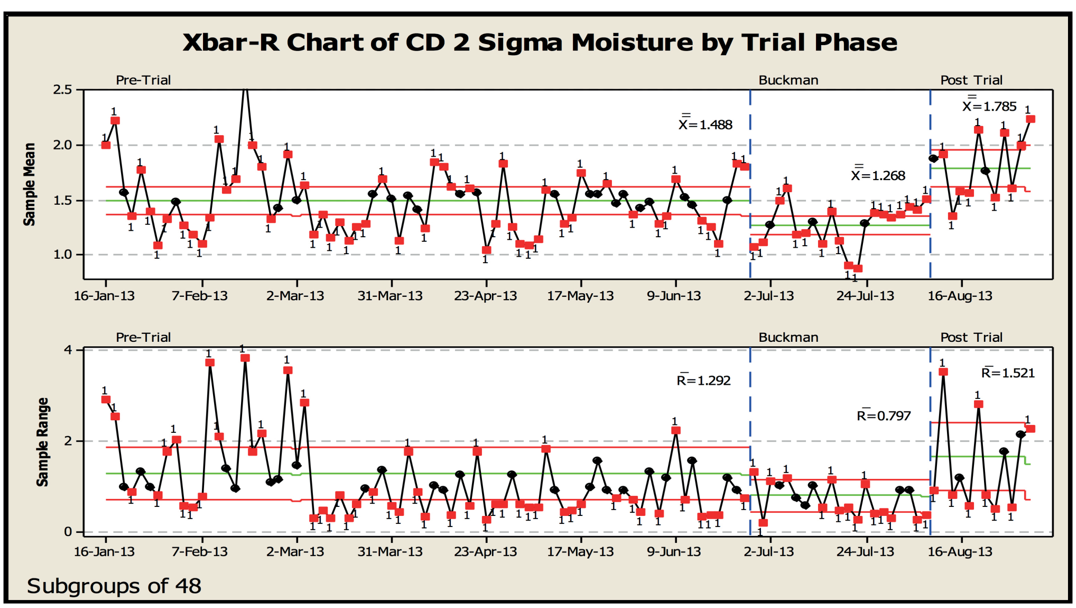

Figure 5. *CD 2 Sigma Moisture variation.*

be low because they simply are not at optimum speed or production.

The chart below shows steam usage in the same Xbar-R format. Notice the reverse trial period steam usage is not significantly higher than our trial period. This is primarily due to a significant decrease in production.

CASE HISTORY 3

A 100% Recycled OCC North American mill producing 1600 tpd of linerboard was having issues with downtime due to stickies debris at the drier section. Pre-trial lab work indicated Optimyze® Plus 742 reduced stickies by 45%. In addition to reducing the amount of stickies, Optimyze also detackified any remaining stickies to further reduce downtime.

Optimyze Plus 742 was applied at a rate of at 1 lb/ton and was later reduced to 0.5 lb/ton to the thickener inlet. From the thickener, a portion of the product moves forward with stock to treat stickies on the machine and the rest goes back into the OCC plant to treat stickies in the back system.

Downtime data was taken for a period of four months. Only downtime for sheet breaks and washups was included in the total downtime. From the total downtime, a subset was manually sorted out which could be attributed to stickies related debris breaks. This debris-related downtime excludes such breaks as those related to draws and wads of paper from previous sheet breaks but does include downtime for washups.

Stickies are measured using Buckman's proprietary fluorescent stickies dye with a quantitative image analysis method. Image analysis provides repeatable data on the total surface area of a dyed 150 mm hand sheet. Image analysis software outputs a count of stickies particles, total area of stickies on the hand sheet, the average size of the stickie particle, and the percent area of the hand sheet covered in stickies. The most repeatable measure of stickies content is the percent area.

Data collected for one month before the trial versus data collected during the trial shows a 45% reduction in stickies at the headbox as well as similar reductions on coarse screens, fine screens and high density storage.

Results:

- Reduced stickies on the machine and in the OCC plant
- Reduced debris-related downtime by 64.8%
- For the month of October (the first full month that the chemical was pumped) the following records were set for PM 1:
    - Fewest breaks/month
    - Most tons produced in a month
    - 4-hour average speed record for 26 lb medium was set during the trial and broken twice more during the trial

The estimated ROI of the program for this mill due to decrease in debris-related downtime and increased revenue for uptime increase was calculated to be around $1,800,000 per year.

CONCLUSIONS

The introduction of enzymatic stickies control marked the first chemical technology that addressed the root cause of stickies-related deposition: the tacky nature of the stickie. Buckman's patented enzymatic

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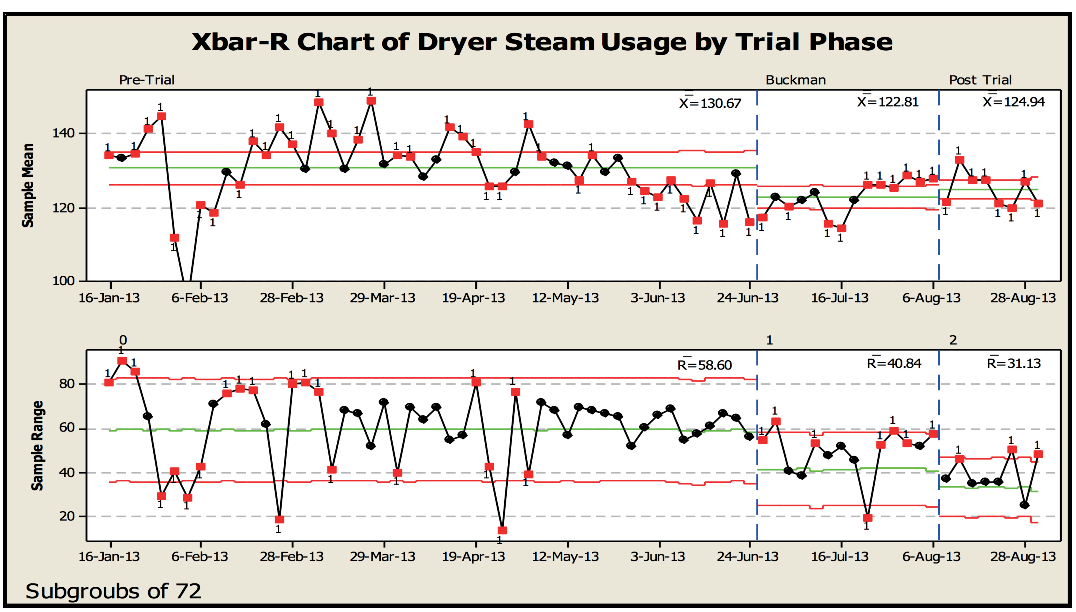

Figure 6. *Steam usage.*

technologies include actives that work together to reduce the size of stickies by breaking the key bonds that are present in the chemical structure of most acetate- and acrylate-containing stickies deposits. Due to the variability of recycled furnish, papermakers rarely have stickies-related deposits from only one type of contaminant. Most stickies deposits found on paper machines or in sheet spots contain a blend of two or more combinations of stickies.

The Optimyze® Plus products have been developed to broaden the range of action to control stickies. Combinations of enzymes and other stickies control chemistries like detackifiers and dispersants are in use or in development. Research into new products continues to help pulp and paper producers fight the stickies that come with the use of recovered fibre and address the new developments from the glue manufacturers.

Following are several of the key areas that need to be considered when calculating the potential ROI with these technologies.

	Pre-trial	Trial
Total days	78.0	38
Total debris-related downtime (min)	2814.0	482
Debris-related downtime/day (min)	36.1	12.7
Total reduction in Debris-related downtime		**64.8%**

Table 3. *Downtime reduction related to stickies debris.*

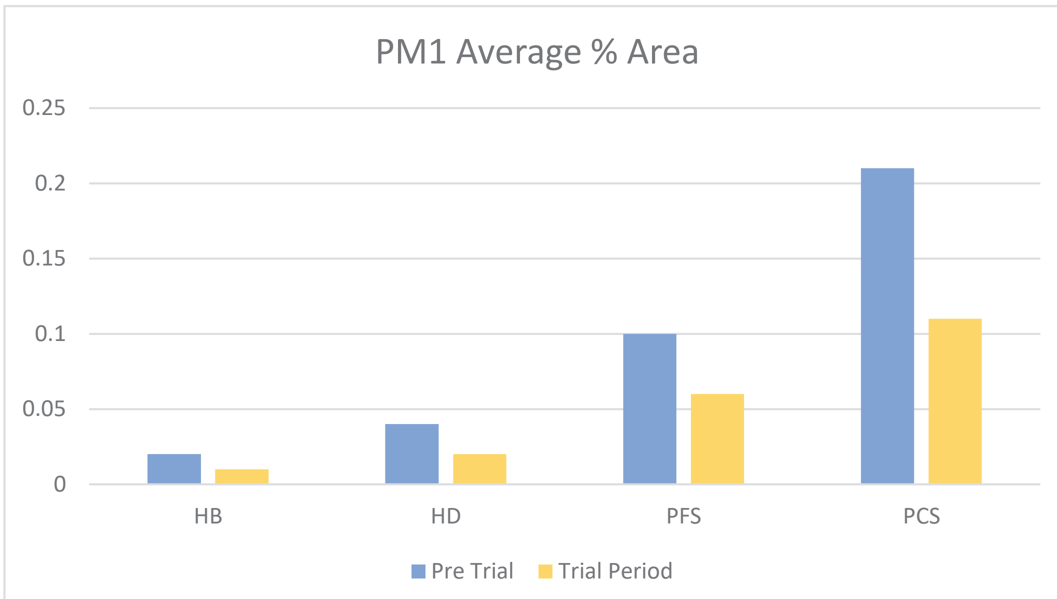

Figure 7. *Stickies size reduction with the addition of Optimyze.*

Improved Machine Efficiency → Fewer Breaks

Improved Sheet Quality → Fewer Holes/Picking

Reduced Washup Time → Less Downtime

Reduction in Overall Chemical Treatment Spend → Less Cost

Eliminated Chemical Makedown → Less Cost

Figure 8. *Potential benefits of Optimyze program.*

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